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Research Article

Features of Stroke Volume Changes among Wheelchair Basketball-Players During Muscular Load Performance

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ABSTRACT

The reaction of the stroke volume among disabled athletes was studied in order to perform a standardized muscular stress and the peculiarities of its recovery after the load completion. The analysis of the stroke volume was carried out in two stages. During the first phase SV indicators at rest were examined among disabled athletes alone. During the second stage disabled athletes performed muscle load in the form of shuttling acceleration during one minute along a basketball court perimeter. Then the features of stroke volume recovery parameters were analyzed.

It was found that during the annual cycle of muscle training the values of stroke volume among wheelchair basketball-players do not change uniformly. The lowest SV values among disabled athletes were registered during the preparatory period, and the highest SV values were registered during the competitive period. It was found that the reaction of stroke volume for muscle load performance and SV recovery time after muscular exercise completion depends on the level of fitness. The higher the level of fitness among wheelchair basketball-players is the shorter the recovery period of stroke volume parameters. The highest SV response for muscular load performance and simultaneously a rapid recovery of stroke volume after the completion of loading is observed during a competitive period. The lowest SV response on muscular load performance and a longer stroke volume recovery is observed during the preparatory period.

Keywords:disabled athletes, stroke volume, muscular exercises, heart response, recovery process.

1. INTRODUCTION

The works of domestic and foreign experts state that the most effective method of rehabilitation among disabled persons is physical culture and sports [1,5,6,7.8,9]. However, the impact of systematic muscle training on the bodies of disabled people was not studied completely. Only a few studies that characterize the paralympic athletes with the lesions of a musculoskeletal system are devoted to wheelchair basketball. Individuals with various lesions of the musculoskeletal system have different morphofunctional and psychophysiological indicators which are studied insufficiently. A considerable interest of researches is shown in the study of pumping function change patterns in a heart during systematic muscle trainings [2,3,4,10,11].

It is reasonable to conduct heart activity studies directly during muscle load performance for a more complete understanding of heart functional possibilities. At the same time the changes of the heart pumping function in the recovery process especially immediately after the cessation of muscular activity indicate the most important regulatory changes in a body [2,3,4]. It should be noted that there are a few works devoted to the

study of basketball players in wheelchairs. There are a few works in literature devoted to the study of functional capabilities of a heart among disabled persons during systematic muscle exercises. Therefore, we examined the response of stroke volume performance among disabled athletes during the performance of muscular load and especially their recovery after the load completion.

The aim of this research wasthe study of stroke volume change peculiarities among disabled athletes during the annual cycle of muscle training.

Research objectives:

1. To study stroke volume reaction among disabled athletes during the performance of muscular load at various stages of muscle training annual cycle;
2. To analyze the features of SV recovery after the muscular load.

2. Research Methods

The studies were conducted among the disabled athletes of the basketball team "Leopard wings". The total number of examined athletes made 15 people. The study of cardiac pump function (CPF) indicators, were conducted in two stages. The first phase examined CPF indicators among disabled athletes at rest. During the second stage disabled athletes performed muscle exercises in the form of shuttling acceleration for 1 minute along the basketball court perimeter. Then the peculiarities of cardiac pump function recovery rates were analyzed. As in all sports the annual period of muscle training among wheelchair basketball players is conditionally divided into three periods: the preparation, the competition and the transition period.

In order to assess the differences the standard values of Stusdent's t-criterion were used.

3.Rheogram registration method

Among rheographic methods for stroke volume determination the method of tetrapolar chest rheography according to Kubicek [12] became the most widely used in various versions. Electrodes are applied according to the scheme; 2 current electrodes: the first one is placed on the head in the forehead area, and the second one is placed on a shank above an ankle joint, two measuring electrodes: the first one on the neck area at the level of the 7th cervical vertebra, the second one is in the chest area, at the level of the xiphoid process.

4.Study Results And Their Analysis

Stroke volume (SV) was registered prior to muscular load, immediately on the completion of load and during the recovery period.

During the preparatory period (September - January) SV among disabled athletes engaged in wheelchair basketball made 37,7 ± 1,4 ml. Systolic ejection indicators during the first minute of the recovery process made 57,4 ± 1,7 ml. This value was 19.7 ml higher compared to the SV values registered before muscular load ($P<0,05$). Thus, stroke volume reacted by 1.5 times increase compared with the original data on the performance of muscular exercises among wheelchair basketball players. During the following minutes the recovery stroke volume significantly decreased. During the second minute of rest SV decreased by 5.7 ml compared to the previous period and made 51,7 ± 1,5 ml ($P<0,05$). During the third minute of recovery process SV made 49,4 ± 1,7 ml. This value was 2.3 ml less as compared with the SV values registered during the second minute of the recovery process. However, this decrease is not statistically significant, i.e. there was a steady trend in SV decrease. During the fourth minute of the recovery process SV indicators decreased slightly more compared with the previous period and made 42,3 ± 1,8 ml, which was 7.1 ml more as compared with the SV indicators registered during the third minute of rest ($P <0,05$). During the fifth minute of recovery process SV indicators decreased by 4.2 ml compared to the previous period and made up 38,1 ± 1,4 ml. Thus, by the fifth minute of the recovery process SV indicators among wheelchair basketball players were established approximately

at the level of the initial values, i.e., stroke volume recovery happened.

Therefore, when the muscle load is performed among wheelchair basketball players SV are increased compared to the original data by 1.5 times approximately. Subsequently, SV values are reduced significantly during the recovery period. However, SV values recovery are different during five minutes of rest.

During the competitive period, i.e. from February to June the disabled athletes engaged in wheelchair basketball the systolic blood volume at rest made 40,7 ± 1,3 ml. During muscular load the stroke volume increased in comparison with the original data by 43.8 ml. and reached 84,5 ± 1,2 ml. (P <0,05). Thus, SV reaction increased in 2 times during muscle load compared with the original data (P <0,05). After the muscle load completion stroke volume was decreasing significantly. During the second minute of rest SV decreased by 29.0 ml as compared with SV values obtained during the first minute of rest and made up 55,5 ± 1,6 ml (P <0,05). During the third minute of recovery process a significant SV reduction occurred and systolic blood output among these athletes was established at the level of original values. Thus, during the third minute of rest SV indicators decreased compared to the previous period of the recovery process by 15.0 ml and were set at the level of 40,5 ± 1,7 ml. (P <0,05). Consequently, during the third minute of rest after the completion of muscular exercises systolic blood output values among disabled sportsmen is set at approximately baseline values. During the subsequent two minutes of rest, i.e. during the 4-th and the 5-th minute of recovery process SV does not undergo any significant changes, making about 39-41 ml.

Thus, during the competitive period SV reaction to muscular exercise was significantly higher than during the preparatory period among the athletes with disabilities playing basketball. So, if during the preparatory period SV increased by 19.7 ml (the increase made 1.5 times) during the competitive period SV increase made 43.8 ml (the increase in 2 times). Therefore, during the competitive period the SV reaction on muscular exercise performance was significantly higher than during the preparatory period. It should also be noted that during the competitive period the restoration of SV to approximately baseline values occurs much more rapidly than during the preparatory period. During the competitive period SV is significantly reduced within the first two minutes of rest, and during the third minute of the recovery process it is set at approximately baseline values. During the preparatory period, the pace of SV recovery is slowed down. SV restoration is observed only by the fifth minute of rest. In the competitive period SV recovery happens during the third minute of rest. Consequently, SV reaction to the execution of muscular load was significantly higher during the competitive period. At that, SV recovery to its original levels is much faster during the competitive period.

Our studies showed that the stroke volume at rest during the transition period (July-August) among the disabled athletes involved in wheelchair basketball made 38,7 ± 1,7 ml. During the performance of standard muscle exercise SV increased by 20.5 ml and reached 59,2 ± 1,9 ml (P <0,05). Consequently, SV increased by 1.5 times during the muscle load performance in comparison with the original data. After the completion of muscle load SV decreased significantly and by the third minute of rest it was set at the level of original values (39,7 ± 2,1 ml). During the next two minutes of rest (the fourth and the fifth minutes of rest) systolic blood output did not undergo any significant changes, remaining at about 39-40 ml. Thus, during the transition period SV reaction on the performance of standardized muscular exercise was not so high compared to the competition period. SV restoration approximately to baseline values occurred in the same way as during the competitive period by the third minute of rest.

Thus, analyzing the dynamics of stroke volume changes among disabled athletes at different

stages of muscle training annual cycle, we identified the following features:

- During the preparatory period SV reaction to the execution of standard muscular load among wheelchair basketball players made 19.7 ml, i.e. SV increase made 1.5 times. After the completion of the muscular load SV restoration happens in a slowed rate and evenly, 5-7 ml. per minute of rest on average. SV recovery to baseline values occurs, however, only during the fifth minute of rest;
- During the competitive period the disabled athletes playing basketball had significantly higher SV reaction on muscular load performance than during the preparatory period. It should also be noted that during the competitive period VS recovery to baseline values occurs much more rapidly than during the preparatory period. After the completion of muscular load during the competitive period SV reduces significantly during the first two minutes of rest, and by the third minute of the recovery process it is set at approximately baseline values. Consequently, as the level of fitness increases among disabled athletes, the recovery period of stroke volume is reduced after the muscle load;
- At the end of the season, i.e., during transition period SV reaction to the execution of a standard muscular stress among disabled athletes declined slightly in comparison with the competition period and made only 20.5 ml (SV increased in 1.5 times). However, the pace of SV recovery after the muscular load remained high. VS restoration to initial values was observed as during the competitive period within the third minute of rest. Therefore, if disabled athletes have some SV reduction at muscular load performance during a transition period, the pace of systolic blood volume recovery after the muscular load remains high, as in the competitive period.

Change of stroke volume values among wheelchair basketball players

Record time	Annual training stages		
	Preparatory	**Competitive**	**Transitional**
SV original values	37,7 ± 1,4	40,7± 1,3	38,7± 1,7
1st minute of recovery	57,4 ± 1,7*	84,5± 1,2*	59,2± 1,9*
2nd minute of recovery	51,7± 1,5	55,5± 1,6	45,7± 1,7
3rdminute of recovery	49,4± 1,7	40,5± 1,5	39,7± 2,1
4th minute of recovery	42,3± 1,8	39,7± 1,7	40,5± 1,7
5thminute of recovery	38,1± 1,4	41,7± 1,2	39,5± 2,5

*- the difference is true in comparison with previous values($P<0,05$).

5.Summary

Systematic muscular workouts impose considerable demands to the bodies of disabled athletes [2,3,4]. At that there is a few works devoted to the study of disabled man body functional capabilities. Furthermore, the available literature has only rare works devoted to the study of disabled people heart pumping function systematically engaged in muscle workouts.

A better understanding of a heart functionality of the heart requires the conduct of heart work studies directly during muscle exercise performance [2,6]. Moreover, the changes of heart beat rate during the recovery process, especially immediately after the cessation of muscular activity indicate important regulatory changes in a body. Therefore, we examined the response of the heart pumping function among disabled athletes on muscular load performance in the form of shuttle acceleration for one minute along the basketball court perimeter.

According to our research, during the preparatory period of muscle training annual cycle SV reaction on the performance of standard muscular load among wheelchair basketball players made 19.7 ml, i.e. SV increase made 1.5 times. After the

muscle load completion SV recovery occurs in a slow rate and evenly, about 5-7 ml per minute of rest on average. However, SV recovery to baseline values occurs only during the fifth minute of rest.

During the competitive period the disabled athletes involved in basketball had a considerably higher SV reaction on muscular load performance than during the preparatory period.

It should also be noted that during the competitive period SV recovery rate to baseline values occurs much more rapidly than during the preparatory period. After completion of the muscular load during the competitive period SV is significantly reduced during the first two minutes of rest, and by the third minute of recovery process SV is set at approximately baseline values. During the transition period, i.e. at the end of the season SV reaction to the execution of a standard muscular load among disabled athletes declined slightly in comparison with the competition period and made only 20.5 ml (SV increase made 1.5 times). However, the pace of SV recovery remained high after muscular load.

Restoration The restoration of SV to the level of initial values was observed, as during the competitive period so as during the third minute of rest. Thus, disabled athletes have the lowest response rates of stroke volume on the performance of muscular load and a longer SV recovery after the muscular load is noted during the preparatory period. As the level of fitness increases, i.e., by the competitive period the stroke volume reaction at muscular load performance and recovery time vary considerably. However, the decrease of these parameters is observed again during a transition period. A sudden change of stroke volume indicators in an annual cycle of muscle training may indicate to some extent about an average level of fitness among athletes. This is proved by the fact that this team showed unstable results throughout the year at various competitions. Vivid performances and victories were followed by unexplained failures from weaker rivals.

6. CONCLUSIONS

1. Stroke volume values change "by leaps and bounds" among disabled athletes during the annual cycle process of muscle training.
2. The lowest SV response and a significantly slowed recovery of systolic blood output among wheelchair basketball players is observed during the preparatory period.
3. The most pronounced reaction to the stroke volume and significantly rapid SV recovery after the muscular load is observed during the competitive period among disabled athletes.

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